

Application No: 10/550,769

Response to Final Office Action dated September 18, 2009

Amendment and Response dated October 29, 2009

Attorney Docket: 1557-4 PCT/US/RCE

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Remarks/Arguments:

Introduction

Claims 9 and 10 have been amended. No new matter is introduced with these amendments. Entry of the claim amendments is respectfully requested.

Section 112 Rejections

In paragraph 6 of the Final Office Action, claims 5-11 and 25 were rejected under 35 U.S.C. § 112, first paragraph, as allegedly lacking enablement for the use of one pin. Claim 10 has been amended to include the use of two pins. Applicant respectfully submits that with the amendments presented herein, the Section 112 rejections are obviated.

Reconsideration and withdrawal of the Section 112 rejections are respectfully requested.

In paragraph 7 of the final Office Action, claims 5-11 and 25 were rejected under 35 U.S.C. § 112, first paragraph, as allegedly lacking enablement for “a flat spray pattern which is substantially parallel to the head”. Applicant respectfully submits that the Specification is enabling, and further with the amendments presented herein the Section 112 rejections are obviated.

In further detail, the Examiner correctly notes that the Specification discloses “an adjustable flat jet nozzle” at page 6, line 3 of the Specification. The Specification, however, is more explicit than the Examiner alleges. For example, a flat jet that is parallel to the axis of the head of the T-piece is clearly shown in Figures 3, 6 and 10. For example, in Figure 3, which is planar or top view of the present invention, a flat spray pattern is shown in that view, i.e., a triangular shaped pattern from the top view. Figures 6a-6c and 10, among others, show a side view of the present invention. In these figures, the substantially flat spray patterns are shown in cross-section. Thus, the Specification clearly describes not only a flat spray pattern, but a flat

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spray pattern which is substantially parallel to the elongate longitudinal axis of the head as depicted in, for example, Figure 3.

The Examiner's assertion that the Specification fails to teach how the opening may produce a flat horizontal spray is simply misplaced. The aperture of the present invention referred to by the Examiner does not produce the flat spray, but rather the size or configuration of the aperture affects the spray angle of the flat spray. (Specification, page 98, lines 1-7). The volume or amount of fluid flow through the aperture is controlled by the spacing of the movable pins. (Specification, page 8, lines 7-10).

Now, what produces the flat spray pattern in the nozzle of the present invention? As shown in Figure 10 and as described in the Specification at page 6, lines 33-36, it is the two curved surfaces that converge at the aperture that produces the flat spray pattern of the present invention. It is not the opening shape of the aperture, as asserted by the Examiner, which produces the flat spray pattern of the present invention. It is also respectfully submitted that one of ordinary skill in the art would readily appreciate for a properly designed nozzle that the controlled convergence of liquids produce a flat spray. For example, see Robert H Perry et al, CHEMICAL ENGINEERS' HANDBOOK 18-61 to 18-62 95th Ed. 1973)(copy enclosed)

Thus, it is respectfully submitted that the Specification is not only enabling for the teaching of a flat spray pattern, but the Specification is in agreement with the general knowledge of one of ordinary skill in the art, in contrast to the assertion made by the Examiner.

Reconsideration and withdrawal of the Section 112 rejections are respectfully requested.

In paragraph 8 of the Final Office Action, claims 5-11 and 25 were rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite. Applicant respectfully submits that with the amendments presented herein, the Section 112 rejections are obviated.

Reconsideration and withdrawal of the Section 112 rejections are respectfully requested.

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Section 102/103 Rejections

Claims 5-7, 10, 11 and 25 were rejected under 35 U.S.C. § 102(b) and claim 8 was rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over US 816,470 to Higgins (hereinafter “Higgins”). Applicant respectfully traverses.

First, with respect to claim 25, Higgins clearly fails to disclose, teach or suggest the claimed limitations of flat end faces of the pins. Plug 10 of Higgins clearly has curved surface 12. As the Examiner has not presented a *prima facie* case of anticipation and/or obviousness against at least claim 25, Attorney for the Applicant respectfully requests that the Examiner withdraw the finality of the September 18, 2009 Office Action and/or consider and make of record all arguments and amendments presented herein.

Now with respect to independent claim 10, Higgins clearly fails to disclose, teach or suggest a nozzle comprising, *inter alia*, “two curved deflectors [that] converge towards the aperture to produce a flat spray pattern which is substantially parallel to the longitudinal axis of the head pipe”, as set forth in amended independent claim 10. (emphasis added). First, the interior (threaded) surfaces apertures 9 of Higgins are not “two curved deflectors [that] converge towards the aperture”. Figure 1 of Higgins clearly shows no curved surfaces of its threaded apertures 9 converging toward discharge passage 7 of Higgins. Nevertheless, the Examiner specifically points to Figure 2 of Higgins and alleges that Higgins shows (somehow) internal surfaces converging toward Higgins’ discharge passage 2. As Figure 2 is an external side view of Higgins’ nozzle 5, any internal structure alleged by the Examiner is merely conjecture.

As Higgins fails to disclose, *inter alia*, two curved deflectors that converge towards the aperture to produce a flat spray pattern which is substantially parallel to the longitudinal axis of the head pipe, the Examiner must then properly apply an inherency argument to the missing descriptive matter of Higgins. To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. *Crown Oper. Int'l Inc. v. Solutia*

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Inc., 289 F.3d 1367, 62 U.S.P.Q.2d 1917 (Fed. Cir. 2002). Further, inherency may not be established by probabilities or possibilities, and the mere fact that a certain thing may result from a given set of circumstances is not sufficient for a *prima facie* case of anticipation. *Scaltech Inc. v. Retec/Tetra L.L.C.*, 153 F.3d 1193, 51 U.S.P.Q.2d 1055 (Fed. Cir. 1999). Occasional results are not inherent. *Mehl/Biophile Int'l Corp. v. Milgraum*, 192 F.3d 1365, 52 U.S.P.Q.2d 1303, 1306 (Fed. Cir. 1999). Clearly, the disclosure of Higgins does not rise to the level of being an anticipatory prior art reference, especially when considering the depiction of Figure 1. For example, the alleged inner threaded surfaces of threaded aperture 9 are not described or depicted as converging toward the discharge passage 7. Further, such alleged inner threaded surfaces of threaded aperture 9 would not be available for directing fluid flow to produce a flat spray because those alleged surfaces would be covered by the threaded portion of plugs 10 and 11 as clearly depicted in Figures 1 and 4 of Higgins.

Moreover, the Examiner states that the "Higgins spray pattern is arguably flat and parallel to the end face of the pins of the head". (Final Office Action, page 5). Here, the Examiner's assertion is in direct contrast to the limitations of currently amended claim 10 which require, *inter alia*, "a flat spray pattern which is substantially parallel to the longitudinal axis of the head pipe".

All claim limitations and claim words must be considered by the Examiner. (*In re Wilson*, 424 F.2d 1382, 1,85, 165 USPQ 4945, 496 (CCPA 1970), MPEP (8th Ed Revised July 2008) §2143.03). It is impermissible during examination to pick and choose from a reference only so much that supports the alleged rejection, and a cited reference must be considered for the entirety of its teachings. *Bausch & Lomb, Inc. v. Barnes-Hind, Inc.*, 230 U.S.P.Q. 416, 419 (Fed. Cir. 1986).

Thus, Higgins clearly fails to disclose each and every limitation of the present invention as set forth in independent claim 10. Therefore, reconsideration and withdrawal of the Section 102(b) rejections are respectfully requested.

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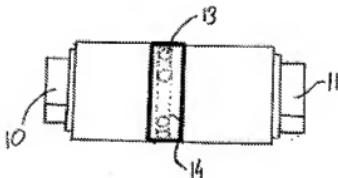
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Furthermore, Higgins fails to teach or suggest the present invention. It is respectfully submitted that one of ordinary skill in the art seeking to create a flat jet nozzle based on the disclosure in Higgins is given little guidance as to the shape of the aperture at the end of through passage 7 of Higgins. This aperture has no reference number in Higgins and is not discussed in the body of the specification. For the sake of clarity it will be referred to here as the “exit aperture”.

None of the Figures in Higgins provide an end view of the nozzle 5, showing the shape or size of the exit aperture. One of ordinary skill in the art must therefore rely on the description in Higgins in order to devise the correct size and shape of the exit aperture. Indeed, one of ordinary skill in the art would refer to Higgins’s earlier US Patent 724,008 as taught by Higgins at page 1, line 42 of the 816,470 patent to Higgins).

It is respectfully submitted that one of ordinary skill in the art would readily appreciate that in order for the discharge passages 13, 14 in the plugs 10, 11 to function the exit aperture must not cover these passages. Both an elongated discharge passage 14 and divided discharge passages 13 in the plugs are disclosed. If either of these passages in the plugs were blocked then the “divided spray” (Higgins, page 1, line 82) or “flattened” discharge (Higgins, page 1, line 85) would simply not be created.

In order for the fuel to flow through the passages 13, 14 of Higgins in the desired fashion the exit aperture must be of an adequate size and shape to facilitate these desired flow patterns. One of ordinary skill, in the art would readily devise a slot-like exit aperture like that shown as a thickened line on the nozzle end view (below) in order to allow fuel to discharge from passages 13 and 14 (shown with dashed lines).



On reading Higgins in light of US 724,008, one of ordinary skill in the art would also determine that "the inlet 3 and outlet 4 passages... are arranged out of alignment or in dissimilar planes, so that the fluids or vapors entering the inlet passages will be directed against the interior walls of the nozzle... so that a more efficient commingling... will be effected". (US 724,008, page 1, lines 20 to 27). On observing that the receiving apertures 6 of Higgins are located out of alignment with passage 7 between the plugs, one of ordinary skill in the art would be further encouraged to provide a slot-like exit aperture like that shown in the drawing above:

It is respectfully submitted that, if one of ordinary skill in the art were to devise a nozzle with a flat spray pattern in accordance with Higgins, the spray pattern would necessarily be transverse to the axis of the plugs 10, 11 of Higgins. As such, Higgins fails to disclose, teach or suggest a nozzle that produces a "flat spray pattern which is substantially to the longitudinal axis of the head pipe" of the T-piece as required by the claim 10 of the present application. It is therefore submitted that claim 10 is patentably distinct over Higgins.

It is also respectfully submitted that Higgins teaches that a slot-like exit aperture is required like that shown in the drawing above in order to generate the desired spray patterns from the passages 13, 14 in the plugs. As such, the "pipe" does not provide an internal curvature which can act to deflect fuel in passage 7. In fact, the "pipe" in Higgins cannot act to deflect the fluid as the formation of a slot-like exit aperture results in removal of the very material that could provide such deflection.

Moreover, Higgins relates to a nozzle for spraying an oil and steam mixture. (Higgins, page 1, lines 40 to 52). It is submitted that, given the presence of the steam, such a mixture

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would behave as a compressible gas, at least for the purposes of determining how it would pass through a nozzle.

Nozzles designed for liquids and gases do not share the same properties. Given the compressibility of gas, the gas behaves differently when it is released into atmospheric conditions as compared with liquids such as water, which are not compressible.

It is submitted that the use of “impingement” deflectors to create a flat jet is a feature of liquid nozzles; and not gas nozzles. The “two curved deflectors that converge toward the aperture to produce a flat spray pattern” as claimed in claim 10, are an example of the use of impingement to create a flat jet.

A flat jet nozzle concentrates the liquid in a thin line. Simply having a slot without converging walls will not cause a liquid to impinge forming a flat spray pattern consisting of individual water particles. If a liquid were to be run through the slot between the plugs in Higgins the liquid would initially form a solid stream in the shape of the slot but would rapidly reform into a round stream. A gas on the other hand would exit the slot in the shape of the slot and continue to expand maintaining substantially the same profile as the slot.

Displacement of the pins in the nozzle of the subject application changes the volume of flow not the shape of the exit plume which remains flat in a thin line. In contrast, rotation of the plugs in Figures 3 and 4 of Higgins results in a variety of changing plume shapes.

In establishing a *prima facie* case of obviousness, the cited reference must be considered for the entirety of their teachings. *Bausch & Lomb, Inc. v. Barnes-Hind, Inc.*, 230 U.S.P.Q. 416, 419 (Fed. Cir. 1986). It is impermissible during examination to pick and choose from a reference only so much that supports the alleged rejection. *Id.* It would be only through hindsight reconstruction and selective picking and choosing while ignoring divergent teachings may the Examiner attempt to reach the present invention through the Higgins. It is also well established, however, that hindsight reconstruction of a reference would not present a *prima facie* case of obviousness, and any attempt at hindsight reconstruction using Applicant’s

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disclosure is strictly prohibited. *In re Oetiker*, 24 U.S.P.Q.2d 1443, 1445-46 (Fed. Cir. 1993). Such attempted picking and choosing is clearly evident as the Examiner applies his own assertions to internal structure not shown in Figure 2 of Higgins and which is not supported by the internal structure depicted in Figure 1 of Higgins.

With respect to the Section 103 rejection of claim 8, Higgins specifically teaches, as acknowledges by the Examiner, that “[t]he size of the nozzle is increased to accommodate said apertures.” (Higgins, page 1, lines 65-67). This is also depicted in Figure 1 of Higgins. Thus, Higgins teaches away from the limitations of claim 8. Nevertheless, the Examiner modifies Higgins in an attempt to arrive at the limitations of claim 8. Such a modification of Higgins would destroy the purpose, intent and function of Higgins. Higgins purposely increases the diameter of its nozzle to “insure structural strength”. (Higgins, page 1, lines 65-68). To modify Higgins to decrease “structural strength” would make the nozzle of Higgins inoperable for its intended purpose, i.e., a structural sound nozzle. An inoperable reference, such as a “modified Higgins” as proposed by the Examiner, cannot form a *prima facie* case of obviousness. *In re Gordon et al.*, 221 U.S.P.Q. 1125, 1127 (CAFC 1984). Therefore, Higgins fails to disclose, teach or suggest the limitations of the present invention as set forth in dependent claim 8.

In summary, Higgins fails to disclose, teach or suggest, *inter alia*, the use of two deflectors that converge toward an aperture to produce a flat spray pattern, as claimed in the present application because Higgins is related to a gas nozzle not a liquid nozzle, and in any case the claimed deflectors are not disclosed by Higgins.

Accordingly, Higgins fails to disclose, teach or suggest the present invention.

Reconsideration and withdrawal of the rejection of the claims under Sections 102(b) and 103(a) are respectfully requested.

Summary

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Therefore, Applicants respectfully submit that independent claim 10, and all claims dependent therefrom, are patentably distinct. Further, rejoinder and allowance of claims 12 and 14-22 are respectfully requested. This application is believed to be in condition for allowance. Favorable action thereon is therefore respectfully solicited.

Should the Examiner have any questions or comments concerning the above, the Examiner is respectfully invited to contact the undersigned attorney at the telephone number given below.

The Commissioner is hereby authorized to charge payment of any additional fees associated with this communication, or credit any overpayment, to Deposit Account No. 08-2461. Such authorization includes authorization to charge fees for extensions of time, if any, under 37 C.F.R. § 1.17 and also should be treated as a constructive petition for an extension of time in this reply or any future reply pursuant to 37 C.F.R. § 1.136.

Respectfully submitted,

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FIFTH EDITION

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under the editorial direction of**

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*The editors for this book were Harold B. Crawford and Ross J. Kepler,
the designer was Naomi Auerbach, and its production was supervised
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Levich¹¹ ("Physicochemical Hydrodynamics," Prentice-Hall, Englewood Cliffs, N.J., 1962) suggests a different form that multiplies Eq. (18-122) by $(\rho_a/\rho_p)^{1/2}$. For liquid dispersed in gas systems past turbulent break-up is usually limited to high-pressure-drop concurrent flow.

A further type of break-up can result from impingement on equipment walls as in pipe bends or compressor blades. Wachters and Westerling [Chem. Eng. Sci., 21, 1047 (1966)] studied 2000- μ droplets impinging on heated walls. They found two break-up modes for these non-wetted surfaces. For Weber numbers (defined with ρ_p) of 30 to 80 the drops spread out on impact, then pulled back together because of surface tension and rebounded in a columnar fashion. The column then followed a Rayleigh-type break-up and yielded two to three droplets. Above a N_w of roughly 80 the drops shatter on impact. Harvey (Ph.D. Thesis, McMaster University, 1967) observed similar phenomena but at lower Weber numbers for 500- μ drops. Virtually no quantitative guidelines exist for impingement on wetted surfaces. This process is complicated by a highly non-linear droplet-size dependence as well as a dependence on the thickness of the liquid film on the wall. In general there is less tendency to shatter on wetted surfaces, although Hobbs and Kezwey [Science, 153, 112 (1967)] demonstrate that this can still be a significant source of spray. (A 3000- μ water droplet falling 18 in. splashes out 10 spray particles; increased height yields proportional increases in spray particles.)

Spray Nozzles (Atomizers). The common need to disperse a liquid in a gas has spawned a tremendous variety of mechanical devices. The different designs emphasize different advantages such as freedom from plugging, pattern of spray, small droplet size, uniformity of spray, high turndown ratio, and/or low power consumption.

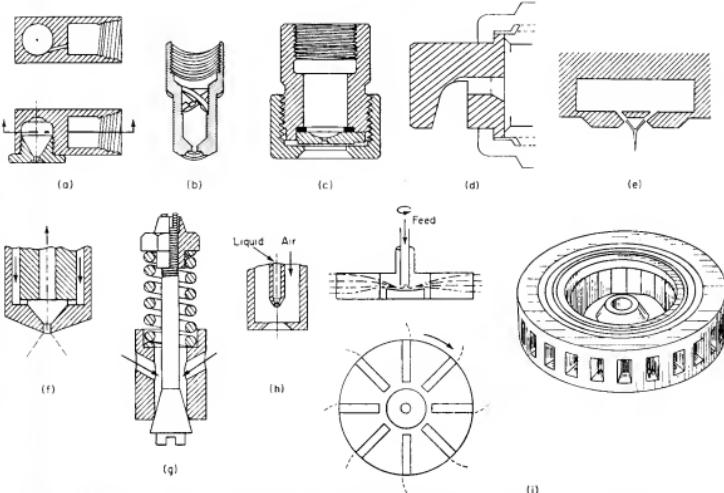


Fig. 18-112. Characteristic spray nozzles. (a) Whirl-chamber hollow cone. (b) Solid cone. (c) Oval-orifice fan. (d) Deflector jet. (e) Impinging jet. (f) By-pass. (g) Poppet. (h) Two-fluid. (i) Vaned rotating disk. [(a), (b), (e), (f), (h), and (i) from Dombrowski and Munday, Biochim. Biol. Eng. Sci., 1968; (d) and (g) Delavan Mfg. Co.; (c) Schutte and Koerting Co.]

As shown in Table 18-21, most nozzles fall into three categories:

1. Pressure nozzles
2. Two-fluid nozzles
3. Rotary devices

These share certain features:

1. Relatively low efficiency. The energy required to produce the increase in area is typically less than 1 per cent of the total energy consumption. This results from the fact that atomization is a secondary process resulting from high interfacial shear. Unfortunately, as droplet sizes decrease this efficiency invariably drops even lower.
2. Reliance on the break-up mechanisms discussed above.
3. Broad droplet-size distribution (see Fig. 18-113).
4. Low cost (relative to most process equipment).

Other types that use sonic energy (from gas streams), ultrasonic energy (electronic), and electrostatic energy offer high potential but are not commonly used in process industries. Tate (Chem. Eng., July 19, 1965, p. 157; Aug. 2, 1965, p. 111) gives a more detailed description of the variety of nozzles available and their diverse special applications. Special requirements such as size uniformity in prilling towers can dictate other approaches to dispersion. Here plates or spinning cylinders are drilled with many holes to develop nearly uniform columns which yield drops by the mechanism described by Eq. (18-117).

Usually the most important feature of a nozzle is the size of droplet it produces. As shown earlier, the heat or mass transfer that a given dispersion can produce is often proportional to $(1/D)^2$. As a result fine drops are favored. On the other extreme, drops that are too fine will not settle, and a common concern is the amount of liquid that will be entrained from a given spray operation. For example, if sprays are used to contact atmospheric air flowing at 5 ft./sec., drops smaller than 350 μ (terminal velocity = 5

Table 18-21. Spray-nozzle Summary

Types of nozzles	Design features	Advantages	Disadvantages
Pressure	Flow $\propto (\Delta P/p_0)^{1/2}$. Only source of energy is from fluid being atomized.	Simplicity and low cost	Limited tolerance for solids; uncertain spray with high-viscosity liquids, susceptible to erosion. Need for special designs (e.g., by-pass, split, multi-orifice) to achieve turndown.
1. Hollow cone	Liquid leaves as conical sheet as a result of centrifugal motion of liquid. Air core extends into nozzle.	High atomization efficiency	Concentrated spray pattern at cone boundaries
a. Whirl chamber (see Fig. 18-112a)	Centrifugal motion developed by tangential inlet in chamber upstream of orifice	Minimum opportunity for plugging	
b. Grooved core	Centrifugal motion developed by insert in chamber	Smaller spray angle than 1α and ability to handle flows smaller than 1α	
2. Solid cone (see Fig. 18-112b)	Similar to hollow cone but with insert to provide even distribution	More uniform spatial pattern than hollow cone	Coarser drops for comparable flows and pressure drops. Failure to yield same pattern with different fluids
3. Fan (flat) spray	Liquid leaves as a flat sheet or flattened ellipse	Flat pattern is useful for coating surfaces and for injection into streams	Small clearances
a. Oval or rectangular orifice (see Fig. 18-112c). Numerous variants on cavity and groove exist.	Combination of cavity and orifice produces two streams that impinge within the nozzle	Minimal plugging	Coarser drops
b. Deflector (see Fig. 18-112d)	Liquid from plain circular orifice impinges on curved deflector	Different liquids are isolated until they mix outside of orifice. Can produce a flat circular sheet when jets impinge at 180° deg.	Extreme care needed to align jets
c. Impinging jets (see Fig. 18-112e)	Two jets collide outside nozzle and produce a sheet perpendicular to their plane		
4. Nozzles with wider range of turndown			
a. Spill (by-pass) (see Fig. 18-112f)	A portion of the liquid is recirculated after going through the swirl chamber	Achieves uniform hollow cone atomization pattern with very high turndown (50 to 1)	Waste of energy in by-pass stream. Added piping for spill flow
b. Poppet (see Fig. 18-112g)	Conical sheet is developed by flow between orifice and poppet. Increased pressure causes poppet to move out and increase flow area	Simple control over broad range	Difficult to maintain proper clearances
c. Dual-orifice	Two concentric orifices, each with its own liquid-supply system. The conical sheets impinge so that the high-velocity stream provides atomization energy	Uniform spray angle throughout range	Small flow passages. Non-uniformity of droplet sizes
Two-fluid (see Fig. 18-112h)	Gas impinges on coaxial (inner flow of liquid) and supplies energy for break-up	High velocities can be achieved at lower pressures because the gas is in a high velocity stream. Liquid-flow passages can be large, and hence plugging can be minimized.	Because gas is also accelerated, efficiency is inherently lower than pressure nozzles
Rotary atomizers. Spinning disks (see Fig. 18-112i) and spinning cups	Liquid is fed to a rotating surface and spreads in a uniform film. Flat disks with vanes, and bowl-shaped cups are used. Liquid is thrown out at 90° deg. to the axis	The velocity that determines drop size is independent of flow. Hence these can handle a wide range of rates. They can also tolerate very viscous materials as well as slurries	Mechanical complexity of rotating equipment. Radial discharge

ft./sec.) will be entrained. Even for the relative coarse spray of the hollow-cone nozzle shown in Fig. 18-112, 7.5 per cent of the total liquid mass will be entrained.

Pressure Nozzles. Manufacturers' data such as shown by Fig. 18-113 are available for most nozzles for the air-water system but rarely for other systems. No all-purpose defining equation for the effect of physical properties exists. The dependence of drop size on geometry, velocity, and properties is complicated by changes in the nature of the break-up process as these variables change. This explains the wide divergence of findings on the importance of surface tension, viscosity, and densities. All the findings are presumably valid for the test conditions but fail on extrapolation to other systems and geometries.

Because of the extreme variety of available geometries, no attempt to encompass this variable is made here. The suggested predictive route starts with air-water data from the manufacturer at the desired flow rate. This drop size is then corrected by Eq. (18-123) for different physical properties:

$$\frac{D_{\text{vm, system}}}{D_{\text{vm, water}}} = \left(\frac{\sigma_{\text{system}}}{73} \right)^{0.5} \left(\frac{\mu_1}{1.0} \right)^{0.2} \left(\frac{\rho_2}{\rho_1} \right)^{0.3} \quad (18-123)$$

where D_{vm} = volume median droplet diameter
 σ = surface tension, dynes/cm.
 μ_1 = liquid viscosity, centipoise
 ρ_1 = liquid density, lb./cu. ft.

Re. 18-113.

The expo averages of is intended relationships simple, Ford at that in the f. different eff size increase deformation is broken. J. Fuel, can both in of operation density: (1) increases the wave length at all. Beca Eq. (18-123)

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